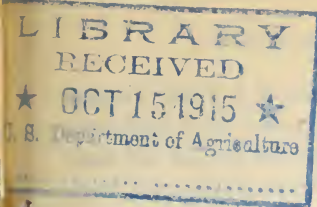


## • Historic, archived document

Do not assume content reflects current scientific knowledge, policies, or practices.





Issued October 12, 1915.

## United States Department of Agriculture,

OFFICE OF THE SECRETARY—Circular No. 53.

### FORMULÆ FOR CALCULATING INTEREST ON FARM EQUIPMENT.

By W. J. SPILLMAN, *Chief, Office of Farm Management.*

In undertaking studies of cost of production on the farm it is necessary to determine a proper basis for calculating interest on the various items of farm equipment. In dealing with the farm business as a whole, or with the business of groups of farms, it is customary to allow interest on the average inventory value of the total equipment. This method is not applicable to studies of the cost of a single enterprise, for the following reason: An expensive machine, such as a twine binder, depreciates greatly in value from year to year. If an old, nearly exhausted machine is used one year and interest is charged on its inventory value, while the next year a new machine is used and interest charged on its inventory value, the item of interest will be much larger the second year than it was the first. If accuracy in cost accounting is to be obtained it is necessary to devise some method of equalizing this item for the same machine from year to year. The following analysis of the problem shows how this can be done with a degree of accuracy sufficient for practical purposes:

#### SEMI-PERMANENT EQUIPMENT USED ONLY AT CERTAIN SEASONS.

Suppose a given item of equipment is used, on the average, through 10 work seasons before it is worn out. Its purchase price represents a part of the expense of conducting the business, but as it is used for 10 seasons we divide this expense equally between the 10 years and debit one-tenth of it to the business of each year. That is, we allow 10 per cent depreciation each year, which is the same thing as charging one-tenth of the purchase price to the expense account for the year.

The question now arises as to the sum on which we should allow interest yearly during the life of such equipment.

Suppose the item is a twine binder and that the binder is bought and paid for just before harvest begins, which is usually the case. The money thus spent is all invested in the business from the date

of purchase till the grain crop is converted into usable funds. During this interval the whole purchase price of the machine should bear interest. But when the grain crop is converted into cash we may consider that one-tenth of the purchase price of the machine has been returned and is available for use, and hence ready to earn interest in some other way. From this time to the same time the next year we should charge interest on only nine-tenths of the cost of the machine. At the end of each succeeding year, or, more accurately, at the time of year when the grain crop is disposed of, which for simplicity we will assume is the same each year, we charge off an additional tenth of the cost. During the last year the machine is used, which is here assumed to be the tenth year, only one-tenth of the cost is allowed to bear interest.

We thus have the whole cost bearing interest for a portion of the first year (from the date of purchase to the date when we realize on the farm products). During the second year nine-tenths of the cost bears interest for an entire year; during the third year eight-tenths bears interest for a year; and so on till the tenth year, when one-tenth bears interest for a year. The total interest during the entire life of the machine is then the sum of the following expressions for each separate year, in which  $C$  is the cost price of the machine and  $r$  the interest rate:

Year.	Interest.
First.....	$\frac{10}{10} C r$ for part of a year.
Second.....	$\frac{9}{10} C r$ for 1 year.
Third.....	$\frac{8}{10} C r$ for 1 year.
Fourth.....	$\frac{7}{10} C r$ for 1 year.
Fifth.....	$\frac{6}{10} C r$ for 1 year.
Sixth.....	$\frac{5}{10} C r$ for 1 year.
Seventh.....	$\frac{4}{10} C r$ for 1 year.
Eighth.....	$\frac{3}{10} C r$ for 1 year.
Ninth.....	$\frac{2}{10} C r$ for 1 year.
Tenth.....	$\frac{1}{10} C r$ for 1 year.

Assuming for the present that the interest period the first year is the entire year, the total interest for the 10 years would be the sum of an arithmetical series of which  $\frac{10}{10} C r$  is the first term,  $\frac{1}{10} C r$  the last term and  $\frac{1}{10} C r$  the common difference. This sum is  $(10+1) C r/2$ . In general, where  $n$  is the number of years during which the machine is used, the total interest for  $n$  years is  $(n+1) C r/2$ .

Let  $f$  represent the fraction of the first year that elapsed before the money was invested in the machine. The above expression for the interest for  $n$  years include the interest on the entire purchase price for this fraction of a year, which is  $f C r$ . The actual interest to be computed for the  $n$  year period is therefore  $(n+1) C r/2 - f C r$ . The average interest per year during the period is found by dividing this



last expression by  $n$ , which gives  $(n+1) C r/2 n - f C r/n$ . Since the interest is the product of the principal and the rate, dividing the last expression by  $r$  will give the average principal on which to count interest yearly during each year the machine is used. This gives  $(n+1) C/2 n - f C/n$ , which may be written  $(n+1-2 f) C/2 n$ . If  $f$  be a half year, which it is approximately in many cases, this last expression reduces to  $nC/2n$ , or  $C/2$ . That is, the average yearly investment in the machine, assuming that its purchase price is invested during half the first year, is half the purchase price. Since it is impossible to establish any general rule for determining the exact date when the year's returns from the business actually come in, and since items of equipment that are used seasonally are on hand approximately half the first year they are used, for all seasonally used farm equipment lasting for a term of years we may, in determining the cost of farm operations, appropriately adopt half the purchase price as the basis for calculating interest.

#### SEMIPERMANENT EQUIPMENT USED CONTINUOUSLY.

Some items of farm equipment are used at all seasons of the year and must be replaced immediately when the old equipment is discarded. This is true of farm vehicles, feed cutters, carpenter tools, harness, etc. In this case the total interest to be allowed during the entire life of the item of equipment is the sum of the series mentioned under the previous heading, or  $(n+1) C r/2$ . Dividing this by  $n$  will give the interest to be charged yearly, and dividing again by the rate of interest will give the average basis on which to count interest from year to year. This gives  $(n+1) C/2n$ , which may be more conveniently expressed in the form  $\frac{n+1}{2n} C$ .

In other words, in the case of equipment used continuously, and which therefore must be replaced immediately when the old equipment is discarded, to ascertain the proper basis for counting interest from year to year add 1 to the estimated life of the machine in years, divide the sum by twice the estimated life, and multiply the quotient by the original cost of the implement.

For implements which last a large number of years this value approaches very closely to the value  $C/2$ , and in such cases the latter value may be used without serious error. But for equipment which lasts for only a few years, the difference between the two bases for calculating interest becomes considerable. Thus, if  $n$  is two years, the proper basis for counting interest on an implement of this kind is three-fourths of the original cost. For equipment lasting three years it is two-thirds of the original cost, and so on.

Since most items of farm equipment last, on the average, for approximately ten years, there will be no serious error in allowing interest in all cases of semipermanent equipment on half the original cost. It must be remembered, however, that this is less than the average inventory value of a large number of items of equipment, and costs estimated on this basis will be somewhat too low. For continuously used equipment lasting, on the average, ten years, the proper basis for estimating interest is 55 per cent of the original cost, and the error in using half the original cost as a basis for counting interest is the interest on 5 per cent of the original cost.

#### SUPPLIES.

In the case of cattle bought for feeding, the money is invested in them during the time between their purchase and their sale, and in counting the cost of the feeding operations interest should be allowed on the purchase price of the cattle for this length of time. If home raised, interest should be calculated on the estimated value at weaning time. In the case of materials such as feed, fertilizers, etc., the money invested in them is completely returned when the crop products are disposed of. Under ordinary circumstances this would average somewhat less than a year. In ordinary farm accounting we may count interest on yearly supplies for the time the money is actually invested in them if this is known, or if home grown from the time such supplies could have been sold. In the absence of such data interest for the entire year may be counted on the average value of such supplies on hand during the year.



